

Listing of the Claims

Please amend claims 1 and 9, and add new claims 11-16 as indicated below. This listing of claims replaces all prior versions.

1. (Currently amended) A method for subtracting quantization noise from a pulse code modulated PCM signal being segmented into frames, comprising the steps of:

calculating for each frame of said PCM signal a constant quantization noise level B_q according to the following equation:

$$B_q = \sqrt{\sum_{n=0}^{W-1} \frac{\{(s_{\min}^*[n] - s_{\max}^*[n]) \cdot w[n]\}^2}{12}}$$

wherein

n : indicates a specific sample of the PCM signal; $S_{\min}^{*[n]}$: represents the minimum quantization noise level for a specific sample value $s^*[n]$ of said PCM signal; $S_{\max}^{*[n]}$: represents the maximum quantization noise level for the specific sample value $s^*[n]$ of the PCM signal, wherein $S_{\min}^{*[n]} - S_{\max}^{*[n]}$ has a different value for at least two specific samples n respectively;

$w[n]$: represents a window-function; and

W : represents the number of samples per window; and

subtracting the quantization noise as represented by said quantization noise level B_q from said PCM signal.

2. (Original) The method according to claim 1, characterized in that the minimum quantization level S_{\min}^* as well as the maximum quantization level S_{\max}^* are known.

3. (Previously presented) The method according to claim 1, characterized in that the minimum quantization level S_{\min}^* and the maximum quantization level S_{\max}^* are predicted according to the following equations:

$$S_{\min}^* = i[n] - (i[n] - i_{\min}[n]) / 2$$

$$S_{\max}^* = i[n] + (i_{\max}[n] - i[n]) / 2$$

wherein

i: represents one out of a plurality of possible representation levels predefined due to the specific PCM quantization method applied to an original signal;

i[n]: represents that predefined representation level which corresponds to the sample value $s^*[n]$ for a specific n;

$i_{\min}[n]$: represents that representation level which is--started from i[n]--the next smaller non-zero representation level for which $u[n]=1$;

$i_{\max}[n]$: represents that representation level which is---started from i[n]--the next bigger non-zero representation level for which $u[n]=1$;

with the usage array $u[i]$ being defined to:

$$u(i) = \min \left(1, \sum_{n=0}^{L-1} \begin{cases} 0, & s^*[n] \neq i \\ 1, & \text{otherwise} \end{cases} \right), -2^{N-1} \leq i < 2^{N-1}$$

wherein

L: represents the number samples of the whole PCM-signal; and

N: represents the number of bits used for quantizing an original sample value by using PCM to generate the PCM sample values $s^*[n]$.

4. (Previously presented) The method according to claim 1, characterized in that the subtracting of the quantization noise represented by said quantization noise level B_q from the PCM-signal is carried out in the frequency domain according to the following steps:

computing the spectrum $S^*[k]$ of the PCM signal $s^*[n]$ and forming the magnitude $|S^*[k]|$ thereof;

computing a signal-to-noise ratio $SNR[k]$ of said spectrum $S^*[k]$ according to:
 $SNR[k] = |S^*[k]|^2 / B_q$;

calculating from said signal-to-noise ratio $SNR[k]$ a filter magnitude $F[k]$ according to a predefined filter algorithm based on at least one filter update parameter;

calculating an output spectrum $S^b[k]$ at least substantially free of said quantization noise by multiplying both the real part $R\{S^*[k]\}$ and the imaginary part $I\{S^*[k]\}$ of the spectrum $S^*[k]$ with said filter magnitude $F[k]$; and

transforming the output spectrum $S^b[k]$ back into a signal $s^b[n]$ in the time domain.

5. (Original) The method according to claim 4, characterized in that the filter update parameter and thus the filter magnitude $F[k]$ are adjusted such that the quantization noise in the remaining output spectrum $S^b[k]$ is as low as possible.

6. (Original) The method according to claim 4, characterized in that it further comprises the steps of:

weighting the frames of the input PCM signal with a first window $w1[n]$ and calculating the spectrum $S^*[k]$ from said weighted signal;

generating a weighted output signal $s^b_w[n]$ by weighting the signal $s^b[n]$ received after the re-transformation with a second window $W2[n]$; and

calculating a final output signal $S_w^b[n]$ for a current frame of the PCM-signal from said weighted output signal $s^b_w[n]$ such that the transition between two successive output frames and is smoothed.

7. (Original) The method according to claim 4, characterized in that the computation of the spectrum $S^*[k]$ of the PCM signal is done by using a Fast Fourier Transformation FFT; and

the re-transforming the output spectrum $S^b[k]$ back into a time domain signal $s^b[n]$ is done by using an inverse FFT.

8. (Original) The method according to claim 6, characterized in that the first and the second window $w1$ and $w2$ are identical.

9. (Currently amended) A quantization noise subtracting unit for subtracting quantization noise from a pulse code modulated PCM signal being segmented into frames, comprising:

a quantization noise level calculating unit for calculating for each frame of said PCM signal a constant quantization noise level B_q according to the following equation:

$$B_q = \sqrt{\sum_{n=0}^{W-1} \frac{\{(s_{\min}^*[n] - s_{(3)\max}^*[n]) \cdot w[n]\}^2}{12}}$$

wherein

n : indicates a specific sample of the PCM signal;

$S_{\min}^*[n]$: represents the minimum quantization noise level for a specific sample value $s^*[n]$ of said PCM signal;

$S_{\max}^*[n]$: represents the maximum quantization noise level for the specific sample value $s^*[n]$ of the PCM signal, wherein $S_{\min}^*[n] - S_{\max}^*[n]$ has a different value for at least two specific samples n respectively;

$w[n]$: represents a window-function; and

W : represents the number of samples per window; and

a background noise subtracting unit for subtracting the quantization noise as represented by said quantization noise level B_q from said PCM signal.

10. (Previously presented) The noise subtracting unit according to claim 9, characterized in that it is located at a decoder's side.

11. (New) The noise subtracting unit according to claim 9, characterized in that the minimum quantization level S_{\min}^* and the maximum quantization level S_{\max}^* are predicted according to the following equations:

$$S_{\min}^* = i[n] - (i[n] - i_{\min}[n]) / 2$$

$$S_{\max}^* = i[n] + (i_{\max}[n] - i[n]) / 2$$

wherein

i : represents one out of a plurality of possible representation levels predefined due to the specific PCM quantization method applied to an original signal;

$i[n]$: represents that predefined representation level which corresponds to the sample value $s^*[n]$ for a specific n ;

$i_{\min}[n]$: represents that representation level which is--started from $i[n]$ --the next smaller non-zero representation level for which $u[n]=1$;

$i_{\max}[n]$: represents that representation level which is---started from $i[n]$ --the next bigger non-zero representation level for which $u[n]=1$;

with the usage array $u[i]$ being defined to:

$$u(i) = \min \left(1, \sum_{n=0}^{L-1} \begin{cases} 0, & s^*[n] \neq i \\ 1, & \text{otherwise} \end{cases} \right), -2^{N-1} \leq i < 2^{N-1}$$

wherein

L : represents the number of samples of the whole PCM-signal; and

N : represents the number of bits used for quantizing an original sample value by using PCM to generate the PCM sample values $s^*[n]$.

12. (New) The noise subtracting unit according to claim 9, characterized in that the background subtracting unit subtracts the quantization noise represented by said quantization noise level B_q from the PCM-signal in the frequency domain according to the following steps:

computing the spectrum $S^*[k]$ of the PCM signal $s^*[n]$ and forming the magnitude $|S^*[k]|$ thereof;

computing a signal-to-noise ratio $SNR[k]$ of said spectrum $S^*[k]$ according to:
 $SNR[k] = |S^*[k]| / B_q$;

calculating from said signal-to-noise ratio $SNR[k]$ a filter magnitude $F[k]$ according to a predefined filter algorithm based on at least one filter update parameter;

calculating an output spectrum $S^b[k]$ at least substantially free of said quantization noise by multiplying both the real part $R\{S^*[k]\}$ and the imaginary part $I\{S^*[k]\}$ of the spectrum $S^*[k]$ with said filter magnitude $F[k]$; and

transforming the output spectrum $S^b[k]$ back into a signal $s^b[n]$ in the time domain.

13. (New) The noise subtracting unit according to claim 12, characterized in that the filter update parameter and thus the filter magnitude $F[k]$ are adjusted such that the quantization noise in the remaining output spectrum $S^b[k]$ is as low as possible.

14. (New) The noise subtracting unit according to claim 12, characterized in that the background subtracting unit subtracting the quantization noise represented by said quantization noise level B_q from the PCM-signal in the frequency domain further comprises the steps of:

weighting the frames of the input PCM signal with a first window $w_1[n]$ and calculating the spectrum $S^*[k]$ from said weighted signal;

generating a weighted output signal $s_w^b[n]$ by weighting the signal $s^b[n]$ received after the re-transformation with a second window $W_2[n]$; and

calculating a final output signal $S_w^b[n]$ for a current frame of the PCM-signal from said weighted output signal $s_w^b[n]$ such that the transition between two successive output frames is smoothed.

15. (New) The noise subtracting unit according to claim 12, characterized in that the computation of the spectrum $S^*[k]$ of the PCM signal is done by using a Fast Fourier Transformation FFT; and

the transforming of the output spectrum $S^b[k]$ back into the time domain signal $s^b[n]$ is done by using an inverse FFT.

16. (New) The noise subtracting unit according to claim 14, characterized in that the first and the second window w_1 and w_2 are identical.